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A NEW ENDEMIC SPECIES OF *CRATAEGUS* (ROSACEAE) FROM WESTERN NORTH CAROLINA

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ABSTRACT

A new species, **Crataegus oreophila** R.W. Lance (near series *Tenuifoliae*), is described from the Great Balsam Mountains in the Blue Ridge Province of western North Carolina. Comparison of this endemic species is made to three similar and regionally significant species: *C. macrosperma* Ashe, *C. punctata* Jacq., and *C. succulenta* Schrad. The historic anthropogenic open lands in the region are likely contributory to the origin and distribution of the new entity.

KEY WORDS: *Crataegus*, Rosaceae, endemic, Balsam Mountains, North Carolina

During May to November of 2013, critical study was completed for a morphologically distinct entity of hawthorn (*Crataegus*) ranging within the Great Balsam Mountains of western North Carolina. This entity had been observed by the author in at least 5 separate locations within the particular mountain range over a span of 5 previous years. Following extensive searches in the field and detailed morphological analysis of over 100 specimens from 65 locations in the area, it was determined that this plant does not conform to any previously described taxon in the genus. Its distribution and apparent endemism in the Great Balsam Mountains is likely related to historic conditions of land use.

The Great Balsam Mountains are a subset mountain range covering an area of approximately 612 square kilometers (380 square miles), lying completely within the Blue Ridge Province of western North Carolina (Fig. 1). They are divided from adjacent named ranges by the valleys of the French Broad River to the east and southeast, by the Pigeon River and Hominy Creek to the north, by Richland and Scott Creeks to the northwest, and by the Tuckaseegee River to the southwest. The entire block of mountains is situated east of the Cowee Mountains, north of the Blue Ridge Front, and south of the Newfound Mountains and Great Smoky Mountains. The Blue Ridge Parkway traverses the Great Balsam Mountain range between miles 394 to 443, reaching its southernmost point near mile 423.5. Elevations within the Great Balsams range from approximately 640 m (2100 ft) at the lowest point in Hominy Creek Valley to 1954 m (6410 ft) at the highest peak, Richland Balsam. There are 9 peaks which rise 1829 m (6000 ft) or higher and 44 additional peaks exceeding 1524 m (5000 ft). The conspicuous presence of spruce and fir forests in elevations exceeding 1676 m (5500 ft) in this mountain range accounts for the name, since "balsam" is a colloquial term for the associated forest tree Southern Balsam/Fraser Fir, *Abies fraseri* (Pursh) Poir.

The first white settlers moved into the area in the late 1700's. It is suspected that grassy balds occupying many high peaks were already present, and some of these were undoubtedly used and expanded in subsequent decades when livestock were introduced. After 1900, the first industrial logging of forests came to the region and by the 1920's, extensive logging was widespread. Logging locomotives and railways were used to access much of the high spruce-fir forests, and waste materials such as stumps, bark, snags, and branches (slash) were doubtless abundant. One area of the Great Balsam Mountains suffered a catastrophic fire following logging activites and slash accumulation in 1925 and again in 1942. Thousands of acres were burned in the area of Sam's Knob, Black Balsam, Graveyard Fields, and Flower Knob, resulting in organic matter destruction and exposure of mineral

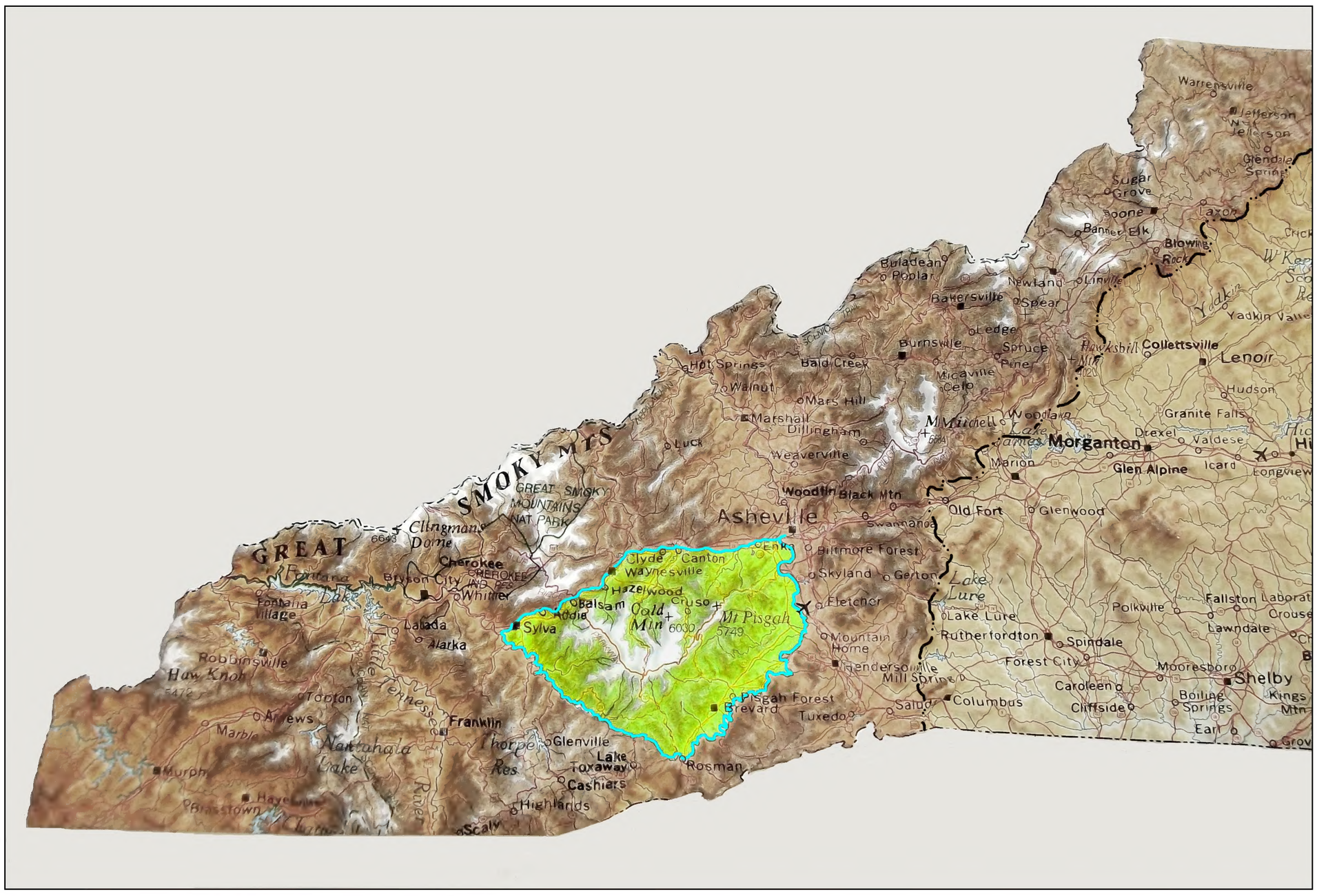

Figure 1. Delineation of the Great Balsam Mountains within the Blue Ridge Province of western North Carolina (west of dashed line). White coloration denotes continuous elevations exceeding 1650 m (5413 ft). Map adapted from Hubbard Scientific raised relief map.

soil. This caused a subsequent slow recovery of forest in this zone but a noticeable "bald" situation that has permitted heavy recreational use by hikers and hunters.

Following the era of industrial logging in the Great Balsam Mountains, grazing among some of the high balds continued. An extensive area of the Great Balsam Mountains used for livestock grazing during 1940 into the 1960's included the vicinity of Old Bald to Wet Camp Gap, in the headwater regions of Caney Fork in Jackson County. Adjoining this region of open land, the boundary line of Haywood County required fences to deter cattle from the Waynesville watershed. Cattle were driven to these high peaks from Caney Fork in Jackson County in spring (May), and rounded up for a return drive in September of each year. Lesser numbers of mules, horses, and hogs were also involved. The livestock were driven up logging roads in the areas of Sugar Creek, Piney Mountain, Beech Flat Creek, Coward Bald, Snaggy Bald, Rough Butt Bald, Wet Camp Gap, and Old Bald. Interviews with elderly residents of the Caney Fork community, including 72-year old Hutey Stephens (2013), recalls a time when 50-75 head of cattle could be seen in some of the high fields of the area, the heavy grazing resulting in short grass "balds" that resembled lawns. Hawthorns or "hawberries" occurred in the periphery of these fields and were remembered because they provided good hunting for ruffed grouse. With the construction of the Blue Ridge Parkway in the 1960's, grazing was curtailed in the highest ridges and balds adjacent to Park Service land. A portion of the open lands was purchased by an employee of the Mead Corporation and he established a Christmas tree plantation in the 1960's to 1970's. Grazing stopped completely during this period, and over 30,000 acres were ultimately acquired by the U.S. Forest Service (Nantahala National Forest) in the mid 1980's as part of the "Roy Taylor Forest." After cessation of grazing, natural succession has

continued to present day, resulting in the regrowth of forest on most previously open lands. Few extensive open areas remain and these continue to decrease in size.

No detailed record of *Crataegus* species that may have occupied positions in the early anthropogenic open lands of the Great Balsam Mountains is available. By comparison to regionally grazed lands extant to present day it can be assumed that *C. macrosperma* Ashe was likely a major component, also in accordance with its abundance throughout this region. Other prospective species might include *C. intricata* Lange, *C. pruinosa* (Wendl.) K. Koch, and *C. schuettei* Ashe in elevations below 5000 feet and *C. punctata* Jacq. and *C. succulenta* Schrad. in higher zones, but these latter two species are not evident today within any area of the Great Balsam Mountains. The relevance of which species may have occupied the grazed lands near Old Bald in earlier times is an issue connected with the assumed origins of the new taxon *C. oreophila* herein described.

The incidence of *Crataegus* within the Great Balsam Mountains in present day is limited to only a few species. In the eastern sections of these mountains, chiefly among rock outcrop communities near the Blue Ridge Parkway between miles 393.6 to 400, *C. aprica* Beadle, *C. calpodendron* (Ehrh.) Medik., *C. uniflora* Muenchh., *C. intricata*, and *C. pruinosa* have been documented (Lance 2006). In the northern sections, mostly at the lower elevations among roads and grazed pasture lands, *C. collina* Chapm. and *C. intricata* have been seen. In the western sections, *C. schuettei* is infrequent. Across the entire mountain range, *C. macrosperma* is common. The entity described here as *C. oreophila* appears to have a core range in the western highlands of the Great Balsam Mountains, with a few outlying specimens located in the center and southern portions of these mountains. Conspicuously absent from the higher elevations of the Great Balsam Mountains is *C. punctata*, a species common in comparable elevations and habitats in other sections of the Blue Ridge of North Carolina and Tennessee.

Crataegus oreophila R.W. Lance, **sp. nov.** Figure 2. **TYPE. USA.: North Carolina.** Jackson Co.: along Old Bald Ridge, NE of Lost Knob, 35°22.487'N, 83°02.258'W, elev 5360', along old road on ridge crest/Mtns to Sea Trail and at point of trail switchback, stamens 5-10, anthers pink, 1 Jun 2013, *R.W. Lance 3679* (holotype: NCU; isotypes: A, BRIT, TRT, US, UWO, VPI, WCU).

Superficially most similar to *C. macrosperma* and somewhat so to *C. punctata* and *C. succulenta*; differing from *C. macrosperma* in its rhombic-elliptic leaf shape with cuneate base and a larger overall mature size; differing from *C. punctata* and *C. succulenta* in its glabrous inflorescences, glabrate leaves, and less thorny nature of branches and trunk.

Small tree, 4–7(–8) m tall, usually single-trunked or sometimes suckering, main stem attaining 5–15 cm diam.; bark gray, scaly; young shoots glabrous, 1 year old twigs pale brown to reddish-brown, older dark gray; thorns yellow-brown or pale brown, slightly recurved, moderately stout, 2–4(–5) cm long, older gray. **Leaves** deciduous; petioles 1–2 cm long, glabrous, grooved adaxially, eglandular or rarely with a few sessile glands; blades 4–8 cm long, 3–7 cm wide, rhombic-elliptic to slightly ovate or obovate, with 4–7 pairs of longer secondary veins, remotely strigose or glabrate adaxially, glabrous abaxially; margins serrate, sometimes with 4–6 pairs of shallow, acute lobes or lobelike apiculi; apex acute, base cuneate or shortly attenuate. **Inflorescences** 5–20-flowered, pedicels glabrous, bearing caducous, linear, slightly gland-margined bracteoles. **Flowers** 15–20 mm diam.; hypanthium glabrous; calyx lobes narrowly triangular, 5–7 mm long, margins glandular-serrate; petals suborbicular, white; stamens 5–10(–12), anthers pink; styles 2–5. **Fruit** 10–18 mm long, subglobose, red when mature, flesh soft, yellow-green, succulent; calyx lobes reflexed; pyrenes 3–4(–5), dorsally ridged, lateral walls plane to slightly concave.

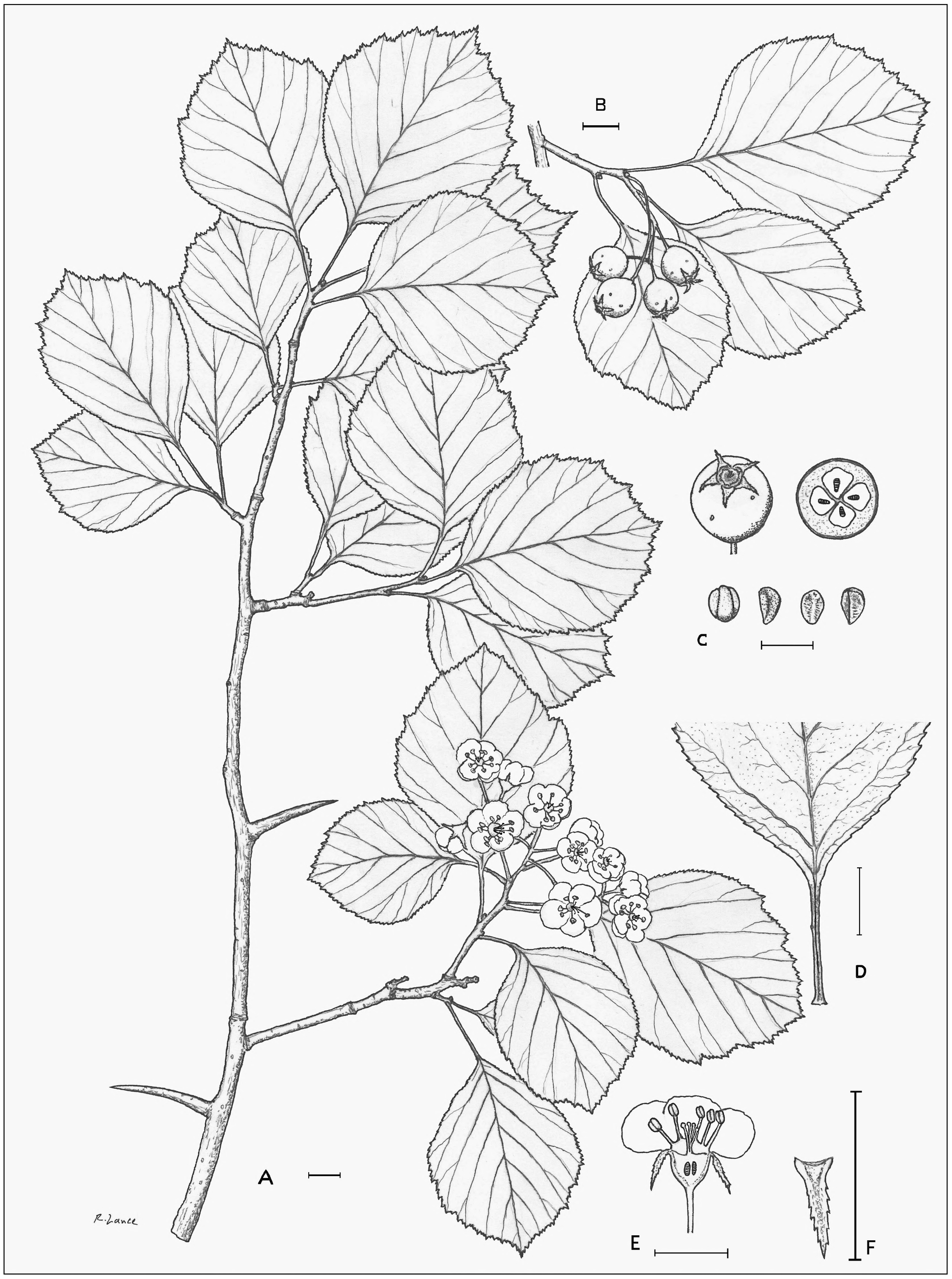

Figure 2. *Crataegus oreophila* R.W. Lance. A= flowering branch, from *Lance 3680* (TRT); B= fruiting short-shoot, from *Lance 3742* (NCU); C= fruit and fruit cross-section, with pyrenes below; D= leaf base and petiole; E= flower; F= calyx lobe, adaxial surface. Scales shown all 1 cm.

Additional specimens: **North Carolina**. Jackson Co.: Along Hwy 23/74, near mile 90 and 200' S of entrance to Balsam Mountain Preserve, E side of road, on slope above drainage, 35°23.958'N, 83°07.469'W, 2 plants, each about 3 m tall, 14 May 2007, *Lance 3099* (NCU); Nantahala National Forest, W slope of Snaggy Bald, along trail about 0.2 mi N of Bald Gap, 35°21.756'N, 83°04.209'W, elev ca 4930', 27 June 2007, *Lance 3116* (NCU); Nantahala National Forest, Snaggy Bald, ca 400' SW of summit on S-facing edge of main ridge, 35°22.957'N, 83°03.959'W, elev ca 5380', 4 mature plants seen, 3-4 inches diameter, stamens 10, anthers pink, 29 May 2008, *Lance 3172* (NCU); Nantahala National Forest, Snaggy Bald, ca 400 ft SW of summit on S-facing edge of main ridge, 35°22.957'N, 83°03.959'W, elev ca 5380', 4 mature plants seen, 3-4 inches diameter, 6 Oct 2008, *Lance 3422* (NCU, WCU); Near entrance of Balsam Mountain Preserve, on E edge of US Hwy 23/74 right-of-way, ca. 200' S of entrance, 35°23.958'N, 83°07.469'W, elev ca 2641', 2 plants, each about 3 m tall, stamens 5-10, anthers dark pink, 5 May 2013, *Lance 3667* (NCU, WCU, TRT); Along Charlie's Creek Road (NC 1756), E of Cathey Gap on Wolf Mtn., 0.3 mi W of bridge over Tanasee Creek, on S edge of road, just S of jct with old logging road, 35°15.624'N, 82°56.682'W, elev. 3828', 3 plants seen, stamens 5-10, anthers dark pink, 25 May 2013, *Lance 3668* (A, BRIT, NCU, US, TRT, UWO, WCU); Along Blue Ridge Parkway at Roy Taylor Forest overlook, near mile 433, 35°22.720'N, 83°0.886'W, elev ca 5460', several large specimens in vicinity, this sample from nearest tree to sign, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3669* (NCU, TRT); Along Blue Ridge Parkway at Roy Taylor Forest overlook, near mile 433, 35°22.715'N, 83°0.864'W, elev 5460', along trail to viewing deck, trunk leaning near horizontal, 7" diameter, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3671* (NCU, TRT); Along Blue Ridge Parkway at Roy Taylor Forest overlook, near mile 433, 35°22.715'N, 83°0.875'W, elev 5460', along trail to viewing deck, trunk hangs over trail, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3673* (TRT); Along Blue Ridge Parkway at Roy Taylor Forest Overlook near mile 433, at N end of overlook, 35°22.741'N, 83°0.947'W, elev 5460', 5 m tall tree by paved drainage ditch, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3675* (TRT); Along Blue Ridge Parkway, near mile 433, 35°22.797'N, 83°01.424'W, elev 5510', along old gated road to E side of Old Bald and Waynesville watershed, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3676* (TRT); Along Old Bald Ridge, NE of Lost Knob, 35°22.493'N, 83°02.320'W, elev 5342', along old road on ridge crest, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3677* (TRT); Between Snaggy Bald and Bald Gap, along old road to W side of Snaggy Bald, 35°21.752'N, 83°04.214'W, elev 4897', single plant on E side of old road, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3678* (TRT); Along Old Bald Ridge, SW of Old Bald, 35°22.615'N, 83°02.106'W, elev 5518', along old road on ridge crest, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3680* (TRT); Along Old Bald Ridge, SW of Old Bald, 35°22.660'N, 83°02.031'W, elev 5505', along old road on ridge crest, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3681* (TRT); Along Old Bald Ridge, SW of Old Bald, 35°22.673'N, 83°01.975'W, elev 5517', along old road on ridge crest, tree 5" diam, in old fenceline on north side of road, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3683* (TRT); Along Blue Ridge Parkway, mile 426.5, Haywood Gap, Jackson/Haywood County line, 35°18.796'N, 82°57.225'W, elev 5170', group of plants on N side of Pkwy, stamens 5-10, anthers pink, 1 Jun 2013, *Lance 3685* (TRT); Along Mtns to Sea Trail, W side of Rough Butt Bald, in head of Rough Butt Creek cove, 35°18.799'N, 82°58.217'W, elev 5344', single plant at base of a *Quercus rubra*, NE of trail, 11 Aug 2013, *M.J. & R.W. Lance 3713* (TRT); Along Mtns to Sea Trail, W side of Rough Butt Bald, in head of Rough Butt Creek cove, 35°18.777'N, 82°58.203'W, elev 5348', three plants E of large *Betula allegheniensis*, NE of trail, 11 Aug 2013, *M.J. & R.W. Lance, 3714* (TRT); Along Mtns to Sea Trail, S side of Rough Butt Bald, E side of trail, on SE-facing slope NE of Wet Camp Gap, 35°18.711'N, 82°58.013'W, elev 5300', single plant, 11 Aug 2013, *M.J. & R.W. Lance 3715* (TRT); Along Mtns to Sea Trail, Rough Butt Bald, at edge of clearing E of main knob, N side of trail, 35°18.941'N, 82°57.627'W, elev 5613', single plant, 11 Aug 2013, *M.J. & R.W. Lance 3716* (TRT); Along Mtns to Sea Trail, E end of Rough Butt Bald, near Blue Ridge Parkway, 35°18.992'N, 82°57.326'W, elev 5360', several large plants in ridgtop flat, under *Betula allegheniensis/Picea rubens*, 11 Aug 2013, *M.J. & R.W. Lance 3717* (TRT); Along Mtns to Sea Trail, SE side of Old Bald

Ridge, N side of trail, near edge of opening, 35°22.522'N, 83°02.077'W, elev 5368', 17 Aug 2013, *Lance 3718* (TRT); Along Mtns to Sea Trail, SE side of Old Bald Ridge, S side of trail, 35°22.568'N, 83°01.918'W, elev 5261', grove of young plants, all less than 8' tall, 17 Aug 2013, *Lance 3720* (TRT); Along Mtns to Sea Trail, SE side of Old Bald Ridge, N of trail at E edge of woods and large opening on ridge leading to Choga Butt Knob, 35°22.579'N, 83°01.843'W, elev 5303', 17 Aug 2013, *Lance 3721* (TRT); Along Mtns to Sea Trail, SE side of Old Bald Ridge, S of trail, on ridge leading to Choga Butt Knob, 35°22.607'N, 83°01.751'W, elev 5150', in *Aesculus/Betula/Amelanchier* forest, 17 Aug 2013, *Lance 3723* (TRT); Along Mtns to Sea Trail, slope between Old Bald and Lone Bald, S of mile 433.5 of Blue Ridge Parkway, 35°22.537'N, 83°01.370'W, elev 5072', several specimens N of trail, 16' tall, 17 Aug 2013, *Lance 3724* (TRT); Along Mtns to Sea Trail, slope between Old Bald and Lone Bald, S of mile 433.5 of Blue Ridge Parkway, 35°22.511'N, 83°01.345'W, elev 5038', several large specimens on gentle slope of ridge, in *Prunus serotina/Aesculus flava* forest, 17 Aug 2013, *Lance 3727* (TRT); Along Mtns to Sea Trail, SW of Lone Bald, in saddle of gap just N of prominent knob on ridge, N of trail, 35°22.372'N, 83°0.843'W, elev 4996', several large specimens in vicinity, 17 Aug 2013, *Lance 3728* (TRT); Along Mtns to Sea Trail, SW of Lone Bald, in saddle of gap just N of prominent knob on ridge, approx. 35°22.372'N, 83°0.843'W, elev 4992', S of trail, 17 Aug 2013, *Lance 3730* (TRT); Along Blue Ridge Parkway, between Spruce Ridge and Lone Bald Overlook, ca 200' SE of overlook, 35°22.539'N, 83°0.272'W, elev 5570', large, fruitful specimen 7" diam, 25' tall, 17 Aug 2013, *Lance 3731* (TRT); Along Mtns to Sea Trail on Judaculla Ridge, W of Richland Balsam, 35°21.839'N, 83°0.440'W, elev 5288', single plant 12' tall, 2" diam, 20' S of trail, 25 Aug 2013, *M.J. & R.W. Lance 3732* (TRT); Along Mtns to Sea Trail, SW of Reinhart Gap, in cove of Piney Mountain Creek, 35°20.044'N, 82°58.486'W, elev 4783', N of trail, in edge of small opening, plant 8' tall, 25 Aug 2013, *M.J. & R.W. Lance 3735* (TRT); Along Mtns to Sea Trail, SW of Reinhart Gap, in cove of Piney Mountain Creek, 35°20.037'N, 82°58.480'W, elev 4784', N of trail, in small opening, plant 7' tall, 25 Aug 2013, *M.J. & R.W. Lance 3738* (TRT); Old Bald Ridge, S of Lost Knob, downslope of gated E end of USFS Rd 4652 (Nantahala National Forest), in head cove of Chastine Creek, 35°22.101'N, 83°02.585'W, elev 4895', single plant 5" diameter, 3 Sep 2013, *Lance 3739* (TRT); Snaggy Bald, SW of summit, on main ridge, 35°21.913'N, 83°04.053'W, elev 5046', two large plants, one 6" diameter, 18' tall, 3 Sep 2013, *Lance 3740* (TRT); Snaggy Bald, SW of summit, along old logging road N of Bald Gap; downslope W of old road, 35°21.721'N, 83°04.234'W, elev 4880', two plants, 10-12' tall, 3 Sep 2013, *Lance 3741* (TRT); Summit of Coward Bald, S end, 35°21.316'N, 83°04.245'W, elev 5041', single large plant 8" diam, 25' tall, hollow at base, 3 Sep 2013, *Lance 3742* (NCU, TRT); Along Old Bald Ridge, NE of Lost Knob, 35°22.487'N, 83°02.258'W, elev 5360', along old road on ridge crest/Mtns to Sea Trail and at point of trail switchback, 8 Sep 2013, *Lance 3743* (NCU, TRT); Along Old Bald Ridge, NE of Lost Knob, 35°22.453'N, 83°02.322'W, elev 5342', along old road on ridge crest, at point of campsite on ridge, 8 Sep 2013, *Lance 3744* (NCU, TRT); S end of Lost Knob, Old Bald Ridge, 35°22.555'N, 83°02.659'W, elev 5354', single plant 12' tall, off N side of ridge, 8 Sep 2013, *Lance 3745* (TRT); Old Bald Ridge, E of Lost Knob, 35°22.389'N, 83°02.070'W, elev 5247', S of old road on partially cleared secondary ridge crest, 15 Sep 2013, *M.J. & R.W. Lance 3752* (TRT); Old Bald Ridge, about halfway between Lost Knob and Chestnut Knob, E side of trail along spine of ridge, 35°21.670'N, 83°02.432'W, elev 4967', double-trunked specimen 3" diam, 14' tall, 24 Sep 2013, *Lance 3760* (TRT); Old Bald Ridge, on summit of Chestnut Knob, 35°21.170'N, 83°02.298'W, elev 4847', two plants at site, 24 Sep 2013, *Lance 3761* (TRT); S of Lost Knob, along Chastine Creek, 35°21.583'N, 83°02.699'W, elev 4376', single plant on E side of creek and old road, 4-stemmed, largest living stem 4.5" diam, 12' tall, 24 Sep 2013, *Lance 3762* (TRT); W of Old Bald Ridge, on spur ridge near jct of USFS (Nantahala National Forest) Roads 4652/4653/4646, 35°21.939'N, 83°02.918'W, elev 4856', two plants, one 3" diam., 24 Sep 2013, *Lance 3763* (TRT).

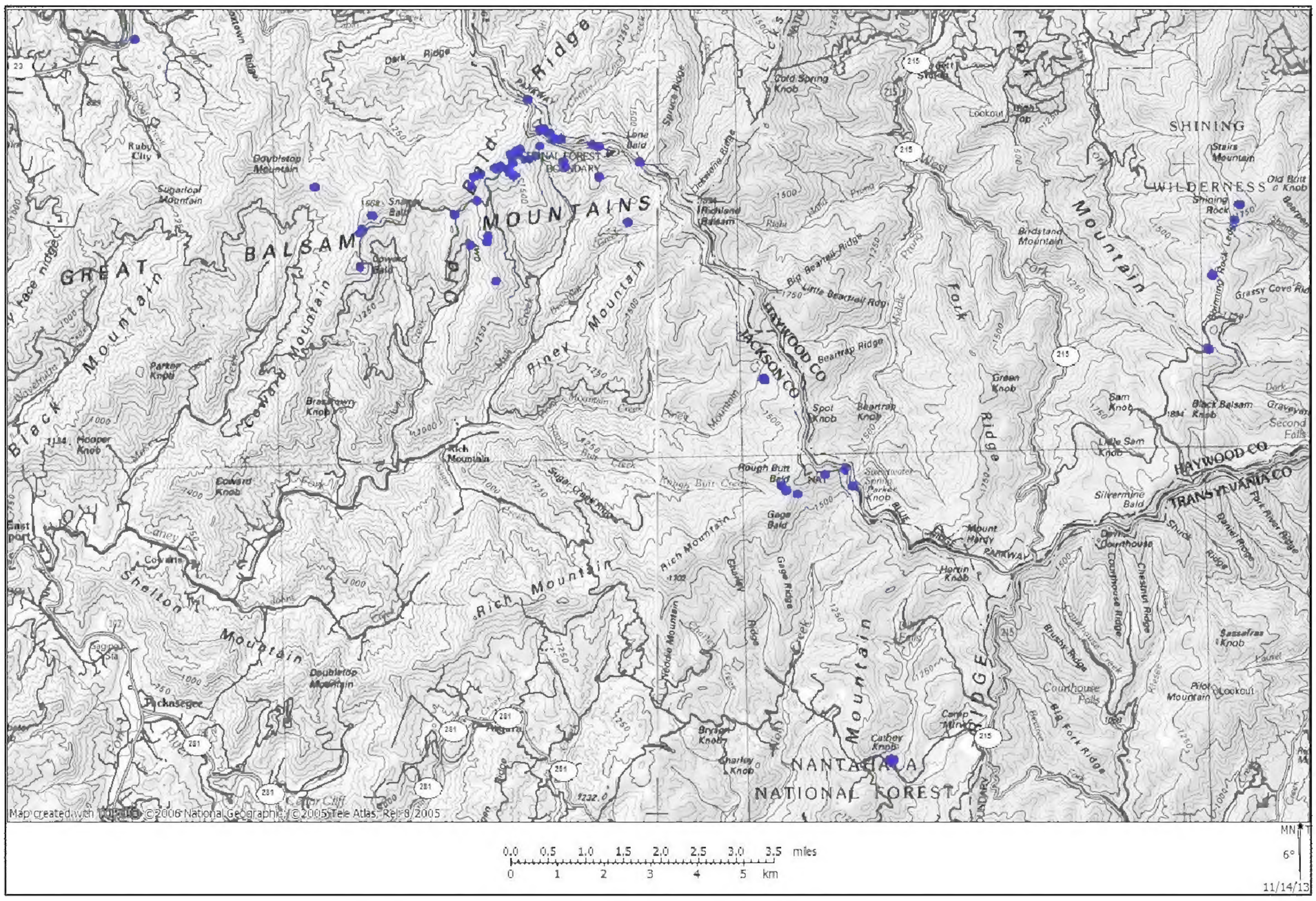

Figure 3. Entire known range of *Crataegus oreophila* in the Great Balsam Mountains. Specimen locations indicated by dots. Map generated with National Geographic USGS Topo! software.

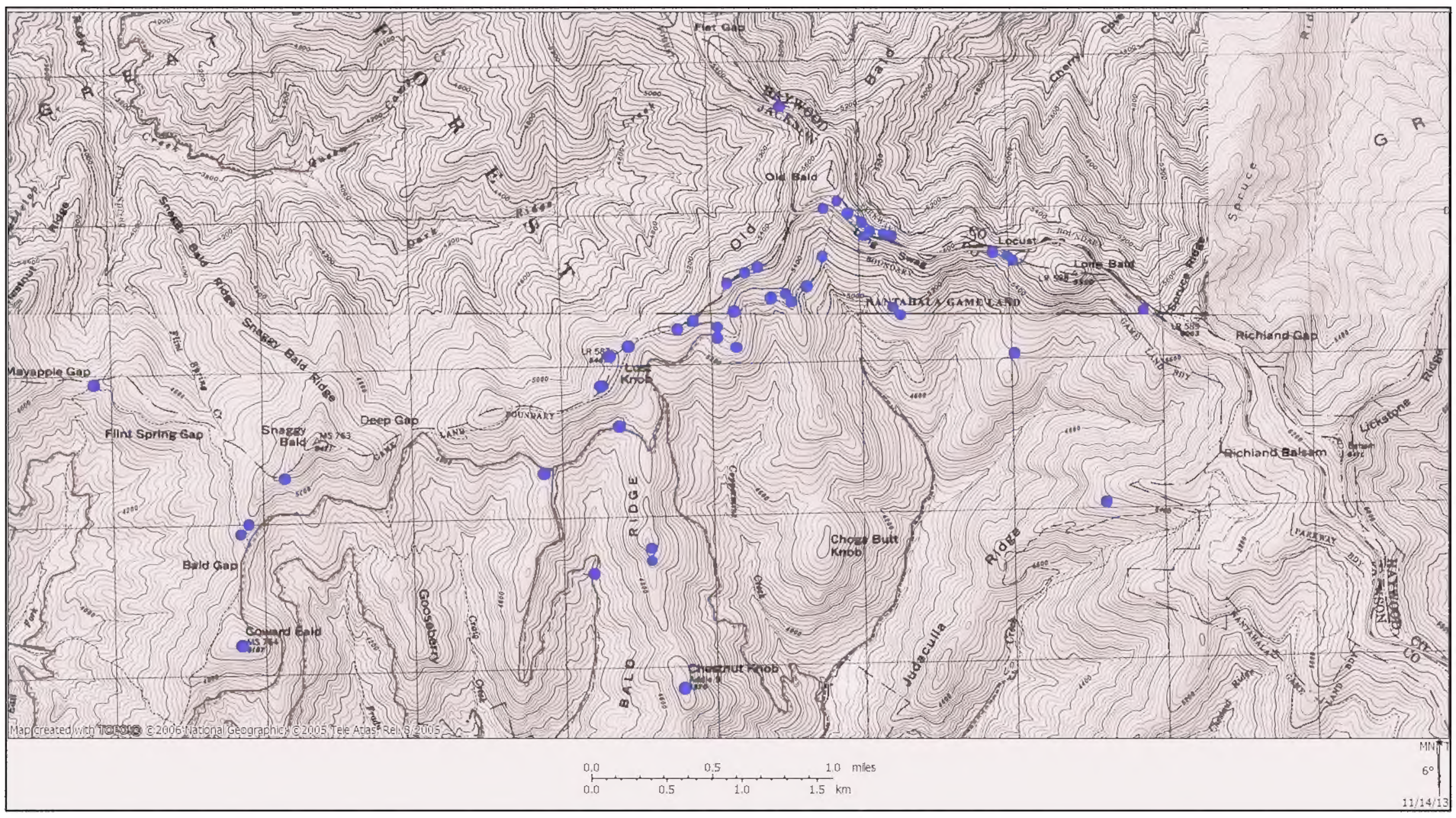

Figure 4. Core range of *Crataegus oreophila* in the vicinity of Old Bald Ridge. Approximately 80 % of specimen locations originated in this area, stations indicated as dots. Map generated with National Geographic USGS Topo! software.

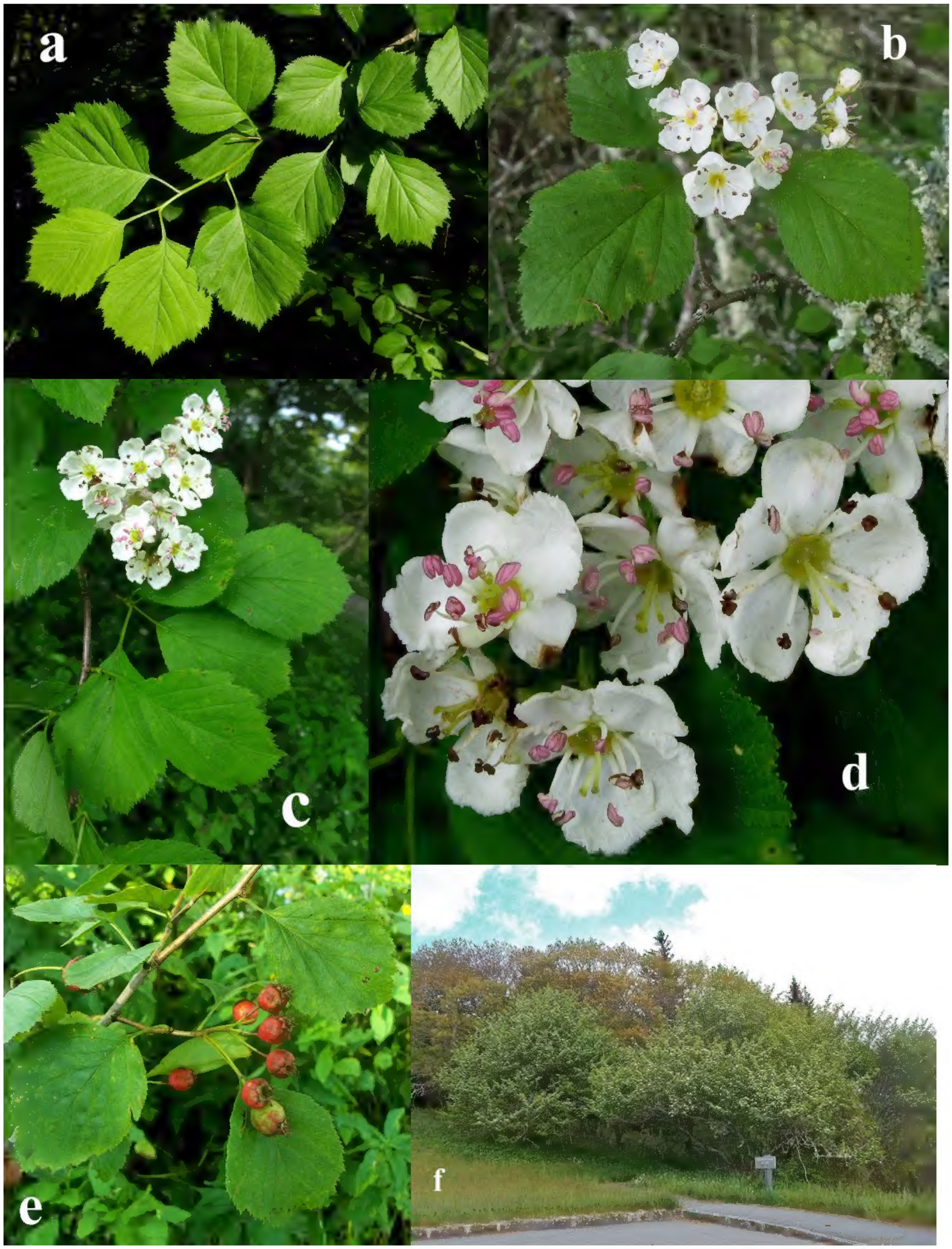

Figure 5. Photos of *Crataegus oreophila*: a= terminal shoot leaves; b= short-shoot leaves and flowers showing 5-10 stamens; c= typical foliage and inflorescence; d= flowers showing 2-5 styles; e= typical foliage and fruit; f= habit of *C. oreophila* at Roy Taylor Overlook, Blue Ridge Parkway.

Figure 6. Photos of *C. oreophila* and comparisons with other species: a= fruits and calyx lobes of *C. oreophila*; b= glabrous inflorescence stems of *C. oreophila*; c= lateral surface appearance of pyrenes among 4 species; d= trunk of *C. oreophila* showing absence of thorns.

Figure 7. Comparative photos of *C. punctata*: a= the 20-stamened flowers; b= inflorescence stems pubescent in *C. punctata*; c= typical trunk of *C. punctata* showing abundant compound thorns

Distribution

Elevational distribution of *Crataegus oreophila* is predominately above 1219 m (4000 ft). Of the 65 sites located and mapped in the field (Fig. 3), only 3% (2 sites) occurred below that elevation (2641 and 3828 ft). Between 1334-1523 m (4376-4996 ft) elevation, 20% of the population was noted (13 sites). The remaining 77% of occurrences (50 sites) were found above 1524 m/5000 ft elevation (5038-5941 ft). This distribution pattern suggests a preference of this species for the elevational zone common to several natural communities of the region: Northern Hardwood, High Elevation Red Oak, Red Spruce-Fraser Fir, Grassy Bald, and Heath Bald. The highest concentrations

of *C. oreophila* were seen in transitional phases of Grassy Bald to Northern Hardwood Forests in the vicinity of Old Bald Ridge (Fig. 4). Throughout the range, older plants having stem diameters of 10-15 cm (~4-6 inches) and heights exceeding 4 m were noted from extant balds and openings, in old fencelines along ridges, in gaps, and on ridgetops or knobs of gentle grade, all having evidence of previous disturbance or absence of forest cover. The species epithet is derived from the Greek words *oreo* (mountain) and *phila* (loving), alluding to the range and habitat preference.

Similarities and possible relationships

Balsam Mountain hawthorn (*Crataegus oreophila*) has been seemingly overlooked by many passing botanists for half a century. Its long presence in the area is attested to by two examples of the plants having been aged by growth ring counts to be approximately 45 years old, and these are not the largest individuals. The ambiguity of its recognition is likely due to its superficial resemblance to two distinct and relatively common species, *C. macrosperma* and *C. punctata*. Regarding the former, *C. oreophila* is easily separated by leaf shape and a larger overall mature size attained. The latter, *C. punctata*, bears distinctly different floral traits, discernable leaf differences and a more thorny nature in branches and trunk; it is not currently known from any location in the Great Balsam Mountains.

Based on morphology, *Crataegus oreophila* has a suggested phylogenetic relationship in the *Tenuifoliae*, notably similar in most respects to *C. macrosperma* (Table 1). Significant toward this assignment are the following traits, all allied to *C. macrosperma*: inflorescences glabrous; stamens usually 5-10 per flower; leaf abaxial surfaces glabrous and adaxial surfaces glabrate or with minute strigose hairs; fruit dull red, calyx sessile and slightly toothed, flesh of mature fruit succulent; thorns of branches usually <4 cm and often slightly curved (Figs. 5,6). Conversely, the leaf shape of *C. oreophila* bears scant similarity to *C. macrosperma*, rarely diverging from its cuneate leaf base. The arborescent, spreading growth habit of *C. oreophila* appears intermediate between the bushy crown that is normal of *C. macrosperma* and the tall, broad and rather flattened branching habit of *C. punctata*. The latter differs from *C. oreophila* in its more obovate leaves with attenuate bases, frequency of compound thorns on trunks and 4-7 cm thorns on branches, pubescence in the inflorescence and 20 stamens per flower (Fig. 7).

As a group, the *Tenuifoliae* are partly defined by broadly ovate to deltate leaf shapes. That *Crataegus oreophila* bears little resemblance in this regard to other *Tenuifoliae* might suggest it is an intermediate. Suspicions of parental affiliation with *C. punctata* or *C. succulenta* can be made on the basis of leaf shape, pyrenes, and the more arborescent habit of *C. oreophila*, in comparison with *C. macrosperma*. In such a hybridization scenario, *C. oreophila* would then be of interserial hybrid origin. Throughout the range of *C. oreophila*, no plants were seen that were of intermediate morphology between *C. oreophila* and *C. macrosperma*, and no other hawthorn taxa was found growing in the vicinity. The closest known populations of *C. punctata* and *C. succulenta* are about 64 km (40 miles) northeast, in the Craggy Mountains of the Black Mountain Range (north of Asheville), across the French Broad River Valley. If *C. oreophila* were to be considered of hybrid origin between *C. macrosperma* and either *C. punctata* or *C. succulenta*, the question arises why there are no comparative examples of *C. oreophila* existing where all three of the suspect parent species today grow in sympatric ranges north of the Great Balsam Mountains.

The pyrenes of *Crataegus oreophila* are typically 4 per fruit (sometimes 3) and tend to be plane to concave on the inner face; this is somewhat divergent from the normal 5 pyrenes within *C. macrosperma* fruit, however pyrenes within local *C. macrosperma* fruits could also be found with plane to slightly concave inner surfaces (Fig. 6c). The occasional distinct concavity in *C. oreophila* pyrenes might suggest some relation to *C. succulenta* of Series *Macracanthae*, these serial members normally having 2 deeply pitted pyrenes per fruit. The calyx lobes of *C. oreophila* are shallowly serrated (Fig. 6a) but not deeply glandular-serrate as is commonly seen in the *Macracanthae*, and

thorn length is conspicuously different between the short-spined *C. oreophila* and the typical long-spined *Macracanthae*. In most cases, few thorns were observed on older specimens of *C. oreophila*. The closest similarity of *C. oreophila* to the *Macracanthae* is seen in foliage shape, to the extent that some specimens of *C. oreophila* have been tentatively identified in the past as *C. succulenta*.

Table 1. Comparison of key traits between 5 *Crataegus* taxa in the North Carolina Blue Ridge.

TRAIT	***C. oreophila***	***C. macrosperma***	***C. punctata***	***C. succulenta***	***C. macracantha***
short-shoot leaf shape	rhombic to slightly ovate or obovate	ovate to deltate	obovate	rhombic to broadly obovate	rhombic to broadly obovate
terminal shoot leaf shape	rhombic to suborbicular or ovate	deltate	broadly obovate	suborbicular	suborbicular
adaxial leaf indumentum	glabrate or finely strigose	finely strigose	finely strigose	glabrate or finely strigose	glabrate or finely strigose
abaxial leaf indumentum	glabrous	glabrous	pubescent	slightly pubescent	slightly pubescent
inflorescence indumentum	glabrous	glabrous	pubescent	glabrate to slightly villous	glabrate to slightly villous
stamens per flower	5-10 (-12)	5-10	20 (-25)	(15-) 20	10 (-15)
anther color	pink	pink to red	pink to red	pink, rarely white	white to yellow, rarely pink
fruit size	10-18 mm	8-15 mm	12-23 mm	7-12 mm	7-12 mm
fruit calyx lobes	finely serrate	remotely serrate	remotely serrate	glandular-serrate	glandular-serrate
pyrenes per fruit	3 to 4	3 to 5	3 to 5	2 to 3	2 to 3
pyrene ventral surface	plane or concave	plane or slightly concave	plane	deeply grooved	deeply grooved
thorns of branches	light brown, 2-4 cm	light to red-brown, 2-4 cm	light brown, 2-6 cm	red-brown, 3-7 cm	red-brown, 3-7 cm
compound thorns on trunk	absent or rare	infrequent	abundant	common	common
growth habit/size	broadly arborescent, 3-8 m tall	bushy to arborescent, 3-6 m tall	broadly arborescent, 3-10 m tall	bushy, 2-5 m tall	bushy, 2-5 m tall
ploidy level	tetraploid	tetraploid, rarely triploid	diploid, rarely triploid	tetraploid, rarely triploid (?)	tetraploid

Only a few other described hawthorn entities have suggested significance in a comparison to *Crataegus oreophila*. One from New York is *C. puberis* Sarg., having been considered of putative interserial hybrid origin between the *Tenuifoliae* and *Punctatae* (Phipps 2005) but described as pubescent in its inflorescence. No other putative hybrid between *Tenuifoliae* and the *Punctatae* or *Macracanthae* has been noted by Palmer (1925) or Phipps (2005). The obscure entity *C. crux* Ashe (no type specimen found), described from Ashe Co., N.C. is also described as pubescent in its inforescence and foliage (Ashe 1901b) and is presumed to belong in the *Macracanthae*; a specimen collected by T.G. Harbison and labeled as such from Ashe County (NCU 81871) displays similar leaf shape to *C. oreophila* but sepals (and a thorn) are much larger and pubescence is present in pedicels and in the bicolored leaves. Another obscure entity, *C. bicolor* Ashe, was named from Mitchell Co., N.C. (Ashe 1901a); its 20 stamens, hard greenish fruit and broad, short sepals as described in the protologue differ substantially from *C. oreophila*. One unusual specimen of *C. macrosperma* having broadly ovate leaves with rounded to subcordate bases (NCU 566823) collected by W.W. Eggleston

(4185) in 1908 from Ashe Co., N.C., may be indicative of introgression of *C. macrosperma* with another Serial member, or perhaps a leaf mutation.

During the course of research for *Crataegus oreophila*, it became apparent that not only had this plant been mistaken for *C. punctata* in previous years (UGA 202737/ *Duncan 31138*, *Lance 3076*, *3092*, *3133*, *3149*, *3172*, *3422*), but *C. punctata* itself was of questionable occurrence in the immediate region. Herbarium records of UNC, UGA, WCU, GSM, and of the author's own collections were reviewed and very few specimens of *C. punctata* were discovered from western North Carolina counties and eastern Tennessee counties south and west of Asheville. Plentiful examples of *C. punctata* occur in the high peaks of the Black Mountain range and northward into the Virginia Blue Ridge, but no records of this plant exist for the Great Balsam Mountains and Great Smoky Mountains. Three specimens are noted from Macon Co., N.C.; from the Nantahala Mountains in the Standing Indian basin (WCU 20788) and along the Nantahala River (NCU 77662, 77664); another plant was seen by the author in this county in the vicinity of Rock Gap. Two unusually disjunct collections of *C. punctata* are noted from Meriwether Co., Ga. (NCU 13944) and Aiken Co., S.C. (NCU 231662). Some confusion exists between *C. punctata* and its southern/lower elevation relative *C. collina*, and in the majority of cases where *C. punctata* was assumed to be present in the Appalachians beyond the southwestern limit of the Black Mountains, it was *C. collina* that was being misidentified.

Origin

Theories of the origin of *Crataegus oreophila* must consider the fact that this tetraploid plant is today an apomictic entity having some affiliation to *C. macrosperma*, another tetraploid apomict. Tetraploids may originate from other tetraploids by sexual reproduction using reduced gametes. They may also originate sexually through irregular gamete reductions from combinations of triploids and tetraploids. Diploid plants may contribute to sexual origins of new triploids by combinations with reduced tetraploid gametes. Polyploid hawthorns, once formed, appear to utilize apomixis as a dominating facet of their reproduction, and the resulting clonal embryos of these apomictic plants contribute to local populations similar in pattern of any sexually reproducing species, except the plants will be virtually identical to each other. It is suspected that *C. oreophila* represents some past sexual combination involving *C. macrosperma* and has since populated widely throughout the general region as an agamospecies. Its initial spread seems to have occurred at a time when the habitat was most favorable. Today it occupies remnant positions in reforested grazing lands and continues to reproduce in areas of disturbance and where sufficient light permits seedlings to survive. Seeds are dispersed by birds and continued new occurrences of this plant may be possible outside the present-day range. Currently, this entity has only been found in the Great Balsams and therefore can be considered endemic to this particular block of mountains.

Limited genetic evaluations of regional specimens of *Crataegus oreophila*, *C. macrosperma*, *C. punctata* and *C. succulenta* were done using flow cytometry. This analyses using leaf, embryo and endosperm tissue was performed by Nadia Talent and Tim Dickinson of the Royal Ontario Museum, Ontario, Canada. Of 72 specimens submitted, the ploidy levels observed between these species were relatively uniform (Table 2). All material derived from the 43 samples of *C. oreophila* revealed tetraploidy (4n). In *C. macrosperma*, 19 samples also revealed tetraploidy, and this taxon was sympatric in virtually every case with *C. oreophila*. The nearest known populations of *C. punctata* and *C. succulenta* were also sampled. Diploidy was indicated in all but one of the 8 samples of *C. punctata* (triploidy in the exception), and 2 samples of *C. succulenta* showed tetraploidy; one of these conforming by its 10-stamen count to *C. succulenta* var. *macracantha* (Lodd.) Eggleston.

Table 2. Ploidy level determinations of leaf tissue for 4 species of *Crataegus* in the North Carolina Blue Ridge. Specimen # to left; ploidy ranges are diploid (2n), triploid (3n), tetraploid (4n) and pentaploid (5n). Total of 72 samples analyzed.

C. oreophila		*C. macrosperma*		*C. punctata*		*C. succulenta*	
3572b	4n	3670	4n	3686	2n	3746	4n
3575	4n	3672	4n	3687	3n	3770	4n
3669	4n	3674	4n	3688	2n		
3671	4n	3682	4n	3689	2n		
3673	4n	3684	4n	3692	2n		
3675	4n	3690	4n	3749	2n		
3676	4n	3691	3n/4n	3750	2n		
3677	4n	3719	4n	3772	2n		
3680	4n	3722	4n				
3681	4n	3725	4n				
3683	4n	3726	4n				
3685	4n	3729	4n				
3713	4n	3734	4n				
3714	4n	3736	4n				
3715	4n	3737	4n/5n				
3716	4n	3751	4n				
3717	4n	3764	4n				
3718	4n	3767	4n				
3720	4n	3771	4n				
3721	4n						
3723	4n						
3724	4n						
3727	4n						
3728	4n						
3730	4n						
3731	4n						
3732	4n						
3735	4n						
3738	4n						
3739	4n						
3740	4n						
3741	4n						
3742	4n						
3743	4n						
3744	4n						
3745	4n						
3752	4n						
3760	4n						
3762	4n						
3763	4n						
3766	4n						
3768	4n						
3769	4n						

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